CLAIMS

1. A coreless linear motor comprising:

a fixed member; and

a movable member moving relatively with respect to the fixed member;

said fixed member having a yoke (51, 151) and groups of permanent magnets (60) fixed to the yoke;

said movable member (2) having a coil assembly (3, 30);

said yoke (51, 151) having first and second facing yoke parts (51A, 51B/151A, 151B) facing each other across a first distance and formed by magnetic materials and a connection yoke part (51C, 151C) connecting first ends of said first and second facing yoke parts;

said groups of permanent magnets (60) including first and second groups of permanent magnets (60A, 60B) arranged so as to face the facing surfaces of the first and second facing yoke parts (51A, 51B/151A, 151B), each of said first and second groups of permanent magnets having a plurality of magnets along the longitudinal direction of the yoke, in the plurality of magnets of each of said first and second groups of permanent magnets, the magnetic poles of magnets facing each other along the longitudinal direction of the yoke differing from each other, and the magnetic poles of the permanent magnets along the

longitudinal direction of the yoke being the same;

said coil assembly (3, 30) having at least three coils (3A, 3B, 3C) arranged movably relative to said first and second groups of permanent magnets (60A, 60B) along the longitudinal direction of said yoke (A1, A2) between the first and second groups of permanent magnets (60A, 60B);

said at least three coils being arranged and wound solidly in multiple layers, then fastened by a binder, the end surfaces of adjacent coils connected with each other via an electrical insulation member;

said coil assembly (3, 30) moving in the space between said facing first and second groups of permanent magnets (60A, 60B) along the longitudinal directions of said yoke (A1, A2).

2. A coreless linear motor as set forth in claim 1, wherein in the cross-sectional shape of each coil, a length (a) facing said first and second groups of permanent magnets (60A, 60B) is longer than a length (B) perpendicular to said first and second groups of permanent magnets (60A, 60B).

3. A coreless linear motor as set forth in claim 1 or 2, wherein

said movable member further has a nonmagnetic reinforcing member (20, 120) fit in solid parts of said coils, and

in the cross-sectional shape of said reinforcing member (20, 120), a length (a) of a side facing said first and second groups of permanent magnets (60A, 60B) is longer than a length (B) of a side perpendicular to said first and second groups of permanent magnets (60A, 60B).

4. A coreless linear motor as set forth in claim 3, wherein a hole through which a cooling agent passes is formed inside the reinforcing member (20, 120).

5. A coreless linear motor as set forth in claim 4, wherein heat radiating fins are formed in a hole inside said reinforcing member (20, 120).

6. A coreless linear motor as set forth in any one of claims 3 to 5, wherein said reinforcing member (20, 120) is produced by aluminum or an aluminum alloy.

7. A coreless linear motor as set forth in any one of claims 3 to 6, wherein

said movable member (2) is further provided with a holding member (10, 110) and spacers (25, 125), and

the two ends of said reinforcing member (20) inserted into said coil assembly (3, 30) are held by said holding member (10) via said spacers (25, 125).

8. A coreless linear motor as set forth in claim 7, wherein said reinforcing member (20, 120) and said spacers (25, 125) are formed by materials having a high heat conductivity and light weight.

9. A coreless linear motor as set forth in claim 8, wherein said reinforcing member (20, 120) and said spacers (25, 125) are formed by aluminum or an aluminum alloy.

10. A coreless linear motor as set forth in any one of claims 3 to 9, wherein the reinforcing member is arranged spaced from the surfaces of the first and second groups of permanent magnets (60A, 60B) by exactly the distance whereby the density of the magnetic flux incident upon the surface of the reinforcing member becomes 1/2 or less of the magnetic flux density of the magnets at the center of the surfaces of the facing first and second groups of permanent magnets (60A, 60B).

11. A coreless linear motor as set forth in any one of claims 1 to 10, wherein the length of said three coils in the longitudinal direction of said yoke (A1, A2) and the length of two adjoining magnets of said first group of permanent magnets (60A, 60B) are equal.

12. A coreless linear motor as set forth in any one of claims 1 to 11, wherein

said coil assembly (3, 30) forming an armature has a first set of 3-phase coils and a second set of 3-phase coils generating magnetic fields of opposite phases, and

the different phase coils corresponding to the first and second sets of 3-phase coils are arranged

adjoining each other.

13. A coreless linear motor as set forth in any one of claims 1 to 13, wherein

said yoke (51, 151) has a square or rectangular cross-section and has first and second facing yoke parts (51A, 51B/151A, 151B) formed by magnetic materials and third and third facing yoke parts (51C, 51D/151C, 151D) perpendicularly intersecting said first and second facing yoke parts (51A, 51B/151A, 151B) and formed by magnetic materials;

said groups of permanent magnets (60) have

first and second groups of permanent magnets (60A, 60B) arranged facing facing surfaces of said first and second facing yoke parts and

third and fourth groups of permanent magnets (60C, 60D) arranged facing facing surfaces of said third and fourth facing yoke parts;

each of said first and second groups of permanent magnets has a plurality of magnets along a longitudinal direction of said yoke, in the plurality of magnets of said first and second groups of permanent magnets, the poles of the magnets facing each other along the longitudinal direction of said yoke being alternately different, and the poles of the permanent magnets along the longitudinal direction of said yoke being the same; and

each of said third and fourth groups of permanent magnets has a plurality of magnets along a longitudinal direction of said yoke, in the plurality of magnets of said third and fourth groups of permanent magnets, the poles of the magnets facing each other along the longitudinal direction of said yoke being alternately different, and the poles of the permanent magnets along the longitudinal direction of said yoke being the same.

14. A coreless linear motor comprising:

a fixed member; and

a movable member moving relatively with respect to the fixed member;

said movable member having groups of permanent magnets (60) arranged at said yoke;

said fixed member having a coil assembly (3, 30);

said yoke (51, 151) having first and second facing yoke parts (51A, 51B/151A, 151B) facing each other across a first distance and formed by magnetic materials and a connection yoke part (51C, 151C) connecting first ends of said first and second facing yoke parts;

said groups of permanent magnets (60) including first and second groups of permanent magnets (60A, 60B) arranged so as to face the facing surfaces of the first and second facing yoke parts (51A, 51B/151A, 151B), each of said first and second groups of permanent magnets having a

plurality of magnets along the longitudinal direction of the yoke, in the plurality of magnets of each of said first and second groups of permanent magnets, the magnetic poles of magnets facing each other along the longitudinal direction of the yoke differing from each other, and the magnetic poles of the permanent magnets along the longitudinal direction of the yoke being the same;

said coil assembly (3, 30) having at least three coils (3A, 3B, 3C) positioned between said facing first and second groups of permanent magnets (60A, 60B), said at least three coils being arranged and wound solidly in multiple layers, then fastened by a binder, the end surfaces of adjacent coils connected with each other via an electrical insulation member;

the movable member having first and second groups of permanent magnets (60A, 60B) facing said coil assembly (3, 30) and said yoke (51, 151) moving along the longitudinal direction of said coil assembly (direct-acting directions A1, A2).

15. A coreless linear motor as set forth in claim 14, wherein in the cross-sectional shape of each coil, a length (a) facing said first and second groups of permanent magnets (60A, 60B) is longer than a length (B) perpendicular to said first and second groups of permanent magnets (60A, 60B).

16. A coreless linear motor as set forth in claim 14 or 15, wherein

said fixed member further has a nonmagnetic reinforcing member (20, 120) fit in solid parts of said coils, and

in the cross-sectional shape of said reinforcing member (20, 120), a length (a) of a side facing said first and second groups of permanent magnets (60A, 60B) is longer than a length (B) of a side perpendicular to said first and second groups of permanent magnets (60A, 60B).

17. A coreless linear motor as set forth in claim 16, wherein a hole through which a cooling agent passes is formed inside the reinforcing member (20, 120).

18. A coreless linear motor as set forth in claim 17, wherein heat radiating fins are formed in a hole inside said reinforcing member (20, 120).

19. A coreless linear motor as set forth in any one of claims 16 to 18, wherein said reinforcing member (20, 120) is produced by aluminum or an aluminum alloy.

20. A coreless linear motor as set forth in any one of claims 16 to 19, wherein

said fixed member further comprises a holding member (10, 110) and spacers (25, 125), and

the two ends of said reinforcing member (20) inserted into said coil assembly (3, 30) are held by said

holding member (10) via said spacers (25, 125).

21. A coreless linear motor as set forth in claim 20, wherein said reinforcing member (20, 120) and said spacers (25, 125) are formed by materials having a high heat conductivity and light weight.

22. A coreless linear motor as set forth in claim 21, wherein said reinforcing member (20, 120) and said spacers (25, 125) are formed by aluminum or an aluminum alloy.

23. A coreless linear motor as set forth in any one of claims 16 to 22, wherein the reinforcing member is arranged spaced from the surfaces of the first and second groups of permanent magnets (60A, 60B) by exactly the distance whereby the density of the magnetic flux incident upon the surface of the reinforcing member becomes 1/2 or less of the magnetic flux density of the magnets at the center of the surfaces of the facing first and second groups of permanent magnets (60A, 60B).

24. A coreless linear motor as set forth in any one of claims 14 to 23, wherein the length of said three coils in the longitudinal direction of said yoke (A1, A2) and the length of two adjoining magnets of said first group of permanent magnets (60A, 60B) are equal.

25. A coreless linear motor as set forth in any one of claims 14 to 24, wherein

said coil assembly (3, 30) forming an armature

has a first set of 3-phase coils and a second set of 3-phase coils generating magnetic fields of opposite phases, and

the different phase coils corresponding to the first and second sets of 3-phase coils are arranged adjoining each other.

26. A coreless linear motor as set forth in any one of claims 14 to 26, wherein

said yoke (51, 151) has a square or rectangular cross-section and has first and second facing yoke parts (51A, 51B/151A, 151B) formed by magnetic materials and third and third facing yoke parts (51C, 51D/151C, 151D) perpendicularly intersecting said first and second facing yoke parts (51A, 51B/151A, 151B) and formed by magnetic materials;

said groups of permanent magnets (60) have

first and second groups of permanent magnets (60A, 60B) arranged facing facing surfaces of said first and second facing yoke parts and

third and fourth groups of permanent magnets (60C, 60D) arranged facing facing surfaces of said third and fourth facing yoke parts;

each of said first and second groups of permanent magnets has a plurality of magnets along a longitudinal direction of said yoke, in the plurality of magnets of said

first and second groups of permanent magnets, the poles of the magnets facing each other along the longitudinal direction of said yoke being alternately different, and the poles of the permanent magnets along the longitudinal direction of said yoke being the same; and

each of said third and fourth groups of permanent magnets has a plurality of magnets along a longitudinal direction of said yoke, in the plurality of magnets of said third and fourth groups of permanent magnets, the poles of the magnets facing each other along the longitudinal direction of said yoke being alternately different, and the poles of the permanent magnets along the longitudinal direction of said yoke being the same.